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of the materials at the expense of which the genital glands are developed. This makes it possible that, while one part of these embryonic materials evolves the male sex, the other may suffer modifications in the direction of the female.

Reptiles.—The lizards of the genus Macroscincus, which are not known to occur on any other spot than the desolate volcanic islet of Branco, three and a half miles south-west of Santa Lucia (Cape Verde islands) are said by M. A. Milne-Edwards to be exclusively vegetable feeders of exceedingly timid disposition. They live in holes among the loose basaltic masses which strew the island. The largest example obtained by the naturalist of the *Talisman* was sixty centimeters in length.

Birds.—The report of the committee for obtaining observations of the migrations of birds at light-houses and light-vessels around and near the British islands, contains much interesting information. Light-vessels moored from five to fifty miles off shore are most favorably placed for such observations. At Heligoland, the rush of migrating birds is more marked and concentrated than anywhere on the English coast. The great rushes on the English east coast in 1883 were on September 21 and the two following days, with moderate cross-currents of air blowing over the North sea, on October 12 and 13, and from the 27th to the 31st of the same month. No less than eight Greenland falcons were shot on the west coast of Ireland during the past year. Not a tithe of the enormous immigration of the autumn returns by the same lines in the spring.

Mammals.—M. A. Milne-Edwards stated in 1871 that, as a result of an examination of the foetal development of Indris, Propithecus, and Lemur, he had concluded that the lemuroids had incontestable affinities with the herbivores. Since that epoch, M. A. Milne-Edwards has examined the embryos of Microcebus, Galago, etc., which yielded the same results, and lastly has dissected a foetus of the aye-aye. This was found to resemble in every essential character those of other lemuroids, while the foetal membranes were those of a typical lemur. The dentition of the young aye-aye is much less different from that of other lemurs than that of the adult, in consequence of the shedding and non-replacement of some of the milk-teeth. The abnormal characters of the species are developed as age advances.

EMBRYOLOGY.[1]

AN OUTLINE OF A THEORY OF THE DEVELOPMENT OF THE UNPAIRED FINS OF FISHES.[2]—The median fins of fishes normally present five well-marked conditions of structure which correspond inexactly to as many stages of development, which, in typical fishes, succeed each other in the order of time. A sixth exceptional form is developed in consequence of an extensive degeneration of the chordal axis and hinder end of the urosome, unaccompanied by an upbending of the hinder end of the axis, as in the case of the evolution of heterocercy. The most primæval stages, or those found to appear in the younger phases of the growth of fishes are somewhat approximated by the structure of the fins of some of the most ancient Devonian, Triassic and Jurassic forms and by such living forms as Chimæra, the Dipnoans and Leptocardians, but the parallelism of the development of the tail of young fishes with the successive modifications of caudal structure found in the forms of successive geological periods is not exact, as we shall presently show.

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[1] Edited by JOHN A. RYDER, Smithsonian Institution, Washington, D. C.

[2] To appear in full in the Proceedings of the National Museum, with plates.

1. *Archicercy.*—The most primitive modification of the urosome is that which I will call *archicercal*, and which is without any median fin-folds whatsoever. While it is true that only a few degenerate or specialized forms of true fishes (Hippocampus, Nerophis) approximate such a condition, it must be admitted that the fins are acquired structures, and that the folds from which they are developed have been acquired in the course of the evolution of the ancestry of the fishes. When a young fish is developing in the egg its tail grows out at first as a blunt prolongation backwards, which is for a time wholly without fin-folds, cylindrical and vermiform in general appearance, with the muscular somites clearly marked.

The larva of Branchiostoma (Fig. 1) is at first without median fin-folds, and that of Petromyzon seems to be without them during the very early stages, and while we must make due allowance in both these cases for the effects of degeneration, we may, I think it probable, look upon these types as possessing at one stage a typically archicercal and vermiform tail. The solitary Urochorda or Ascidians pass through an archicercal stage of development of the urosome. In the course of further development the Ascidians never seem to pass beyond what I have called the second or lophocercal stage when it is absorbed in the caducichordate forms, but persists in the same stage in the perennichordate Appendicularia.

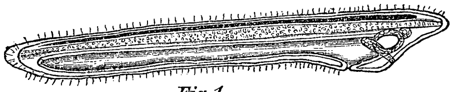


Fig. 1.

The Elasmobranchs seem to pass through an archicercal stage while the Amphibians do not exhibit it in so pronounced a way, very soon becoming lophocercal, though the larva of Dactylethra has the anterior part of the urosome with high median fin-folds while the termination is somewhat like that of *Chimæra monstrosa* (Fig. 2), but tapers more and is typically archicercal (*teste*, W. K.

Parker). After the absorption of the lophocercal tail of anurous amphibian larvæ has been in progress for some time, it seems to tend to lose its median folds somewhat and revert to the archicercal condition. This is also the case with the young of most Urodela as they approach maturity.

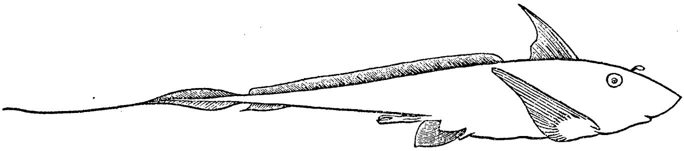
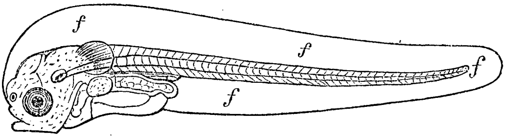


Fig. 2

2. *Lophocercy.*—The second stage of development of the median fin-system of Ichthyopsida is what I have called *lophocercal* (= *protocercal*, Wyman; = *leptocardial*, A. Agassiz) when it consists of continuous folds (Amphibia, Elasmobranchs, Teleosts, etc.), or exceptionally of discontinuous folds (Siphostoma, Gambusia) which do not include permanent rays. The continuity of the median fin-fold in young fishes seems to depend somewhat upon the extent to which the permanent fins are approximated in the adult. Several forms amongst the Clupeoids develop an expanded eradiate caudal fold, with the chordal axis dividing it into equal moieties, which anticipates the form of the outwardly homocercal tail of the adult. At the close of the lophocercal condition the ray-bearing fishes at once diverge from the rest of the Chordata, and also the Urochorda, in that they develop *embryonic rays* in definite regions of the median fin-fold or continuously throughout its entire extent and which give rise to the rays of the distinct or continuous fins of the adult. The intervening parts of the fold in the first case atrophy (—local reversion to archicercy), the materials for the formation of the rays being supplied partially by mesoblastic secretion, while the axial parts are of mesoblastic origin; the materials for the medulla of the rays being supplied by the outgrowth of mesoblast into the fold. The disposition of the materials for the development of the rays of the unpaired fins seems to be very decidedly under the control of heredity, which determines their permanent location or position in

Fig. 3.



the primitive fold, which may therefore be considered the matrix of the permanent fins.[1]

In the formation of rays, their supports and musculature, there is clearly a close correspondence between the number of ray-bearing somites of the body and the one, two or three rays and supports which are developed to each segment, and this is manifested even when heterocercy and its accompanying degenerative processes manifest themselves in the caudal region of the most specialized forms.

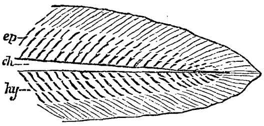


Fig. 4.

3. *Diphycercy.*—The most archaic distribution of the median fin-rays is a continuous one, (as in Fig. 4), and is hypaxial from the vent to the end of the tail and then forward dorsally or epaxially; (Cœlacanthi, Placodermi, Dipnoi, Pleuracanthus). Another archaic trait is the perfectly straight chorda or vertebral axis which extends without upward curvature in typically diphycercal forms to the end of the urosome. (An archaic trait which also marks a phase of the ontogeny of the Teleosts is the Cœlacanthous—hollow—condition of the bony portion of the spines and their supports.) Fishes with a long eel-like body have tended to remain diphycercal, while those whose bodies have been abbreviated have tended, with the exception of such forms as the Heterosomata, to develop discontinuous median fins which have very probably been derived in the first instance, from hypertrophied portions of a continuous series. This hypertrophy in some cases involved the whole series, e. g., Platax. The primæval pre-diphycercal or lophocercal condition is mediately followed by the next stage (Fig. 5) which, as we have seen, must have been developed from a more archaic condition or one of true diphycercy. There therefore occurs a more or less extensive elision or failure to develop a continuous series of rays when specialization sets in so as to produce a discontinuous system of median fins. Embryonic development therefore fails to exactly recapitulate the phases of evolution of the median fins. Even the embryonic rays which are of mesoblastic origin do not always form a continuous series. They are far more numerous than the permanent rays, and are characteristic of the diphycercal condition and represent a stage of fin development which may be called the *protopterygian.*

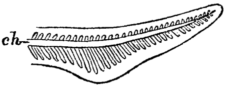


Fig. 5.

These views are fully substantiated by the development of the caudal skeleton of the eel, in which in spite of its slight heterocercy the diphycercal continuity of the fin-series has remained practically unimpaired, thus affording the necessary proof of the *serial homology* of the entire series of median fin-rays and their intermediary supports. (Previous authors failing to attack this part of the problem by the light of the ontogeny of a diphycercal eel-like type have missed the solution of one of the most important minor parts of a rational theory of the median fins, since it is otherwise impossible to prove such a homology in forms with atrophied intervals between the vertical fins.) The mesoblastic skeletogenous tract from which the median fin-rays and their supports are developed, is continuous in the median line of the urosome, above, below and almost over the end of the chorda in fish embryos; such a continuity affords an explanation of why the median fin-rays form an uninterrupted series in cases of perfect diphycercy (Fig. 4), or where the archaic has not been replaced by a specialized mode of development, in the course of which discontinuity has arisen (Protopterus).

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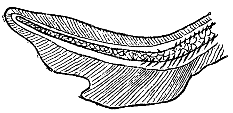
[1] Another article in the succeeding number will deal with the origin of the fin-rays.

4. *Heterocercy.*—Heterocercy affects only the end of the chordal axis, which is bent upwards, and as a result of this it and the subsequently formed terminal vertebral segments are consolidated into a urostyle (many Teleostei), above and below which epaxial and hypaxial skeletal elements are formed, of which the former are, however, often aborted, and the latter widened as supports for the caudal system of rays.

This condition appears to result from two causes: (1) Great activity of growth in the terminal hypaxial part of the primitive caudal fin-fold in consequence of which the chorda is shoved upwards; and (2) from the *actions* of the animal in using the resulting expanded, hypaxial, caudal, ray-bearing fold in swimming; the strokes of the fin in action, owing to the resistance offered by the water, tend to throw up the somatic axis, just as an oar tends to be thrown upward in sculling.

Since the hypaxial fold may be developed at some distance from the end of the tail, in the more specialized forms (Lepidosteus, Fig. 6; Gasterosteus) a more or less extensively free portion of the lophocercal caudal axis is left to project (Fig. 7) during the growth of the true or secondary caudal, the rays of which are mostly hypaxial and serially homologous with those of the anal. The exserted part of the larval axis alluded to above, may be called the *opisthure*, in reference to its position in relation to

Fig 6.



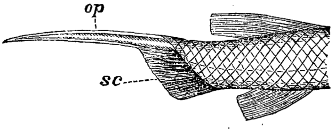


Fig. 7

the permanent caudal. It subsequently degenerates, or it may persist as a prolongation of the chordal axis covered by integument, as in *Chimæra monstrosa* (Fig. 2) or, as in heterocercal Amiurus (Fig. 8), it may, at an early stage, have the chorda exserted beyond the last hypural cartilages and at some distance behind them have another hypaxial cartilage (*op*) developed, which may be called opisthural, as it probably represents the remnant of proximal hypural pieces, which were developed in some more primitive ancestral form in which diphycercy was more pronounced or even perfect. Where the caudal, ray-bearing finfold is developed nearer the end of the chordal axis (Apeltes, Siphostoma, Gambusia,) heterocercy is not so pronounced, as the urostyle is shorter and only one or two of the terminal vertebræ are involved, whereas in other cases (Salmo, Lepidosteus) more terminal vertebræ may be implicated by degeneration. In archaic forms of heterocercy there may be epaxial rays and intermediary supports developed, while the hypaxial supports and rays extend to the end of the upwardly bent termination of the axial column (Fig. 5). This trait may possibly differentiate the archaic type of heterocercy (Palæoniscus, Platysomus, Acipenser, Squali) from the more recent or specialized form (Amiurus, Fig. 8) now prevalent amongst Teleosts, and which have for the most part a more or less well-developed urostyle, but with a very short or included opisthure (= dorsal lobe, A. Agassiz), and with the epaxial spines of the urostyle displaced, rudimentary or aborted. Outwardly homocercal Palæozoic fishes (Dapedius, Pycnodus,) probably had an opisthural filaments developed during their larval stages which subsequently became aborted, as in Lepidosteus, but in others (Platysomus, Pygopterus,) the terminal part of the chordal axis doubtless became segmented, the segments bearing hypaxial caudal rays and few or no epaxial ones, so that their opisthures were probably rudimentary or wanting.

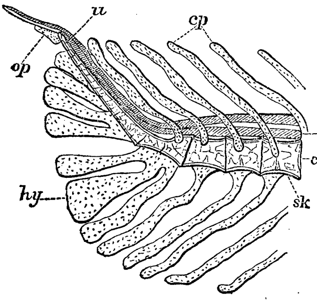


Fig. 8.

It thus becomes evident that the development of modern Teleosts presents only a partial or inexact parallelism with that of the Palæozoic Rhomboganoidei, for few, if any, of these forms show the urostyle so distinctly developed or the hypural pieces so extensively coössified as in existing Teleostei, and we have also shown that there is no such thing even as an exact parallelism to be discovered between the development of the tail of the embryos of the latter and that of the embryos of an existing representative of Palæozoic forms, viz., Lepidosteus (Fig. 6). The Rhomboganoidei, Cycloganoidei, Crossopterygia and Chondrostei show a more decided tendency towards the development of a dorsal and ventral, or, only a ventral series of caudal rays which extend to the end of the caudal axis, and thus trend more towards a diphycercal condition than the existing Teleostei, which may be said to be verging towards *hvpocercy* when all of the caudal rays will be of hypaxial origin, with very often a rayless interval between the last hypaxial pieces and the end of the exserted urostyle (Fig. 8), the latter finally tending to become shorter and be aborted as in Fistularia and Apeltes. These are some of the marks of progress which distinguish the Teleosts and supplement the significant fact of their well-ossified skeleton. It is highly probable that we shall find no remains of the larvæ of Palæozoic fishes in the rocks, so that we have no means of contrasting their early phases with those of existing forms, but it is certain that none of the most simple forms of the Palæozoic fishes, in respect to their caudal skeletal structure, even approximate such a primitive condition as the lophocercal stage of modern forms; the only trait which they possess in common are the continuous median fins; in the first instance containing rays, in the latter case being without them. When we know the larvæ of Ceratodus, Polypterus, Lepidosiren and Protopterus, as well as we know that of Lepidosteus we may have a moderately comprehensive understanding of the main features of the development of Palæozoic fishes.

The evidence in favor of degeneration of portions of the caudal region of fishes is the existence of a permanent archicercal opisthure in *Chimæra monstrosa* and *Stylephorus chordatus;* the extensive development of a temporary opisthure in Lepidosteus; the concrescence of the hypural pieces; the ventrally diplacanthous and even triplacanthous caudal vertebræ (Fig. 8), or their coalesced representative, the urostyle; the existence of hypaxial opisthural elements; the abortion of the epaxial spines of the caudal vertebræ, and finally the abortion or extreme modification of the last muscular somites of the caudal region.

5. *Homocercy.*—This merely expresses the condition of epaxial and hypaxial symmetry presented by the fan-shaped caudal of Teleosts, and is the final term in the evolution of the growth of the rays of that fin, in consequence of which the archaic symmetry of perfect diphycercy becomes again restored, though the axial structure of the tail is heterocercal.

6. *Gephyrocercy.*—This type of tail appears to be normally met with in only two forms of Teleosts, viz., Mola and Fierasfer. The primitive opisthure or end of the urosome in these forms is apparently aborted, in the first, in the course of larval existence, in the other during post-larval life. As a result of this a hiatus is left between the epaxial and hypaxial rudiments of the median fins, and in the center of this hiatus the axial column ends

abruptly as if cut or bitten off, the hinder hypaxial and epaxial tissues concerned in the formation of rays and their supports are then approximated over the end of the aborted axis so as to form a continuous chain, and developed later than the other and more anterior median fin-rays (Mola), and the interval so bridged by a secondary process of development leads to the formation of what we may call a gephyrocercal tail, in which the spinous axial apophyses of the caudal vertebræ, together with their centra, fail to develop, and the caudal rays rest either upon interspinous elements alone, or even these may be almost entirely aborted, as is the case for a time in the young stages of Mola "*Ostracion boöps*" and "*Molacanthus*," both of which are evidently young, post-larval phases of that form.

The views here outlined rest partly upon facts of my own observation, but I must express my great indebtedness to the researches of L. and A. Agassiz, Vogt, Lotz, Balfour, Parker, Huxley and Kölliker, whose labors have enabled me to coördinate the facts and establish doctrines respecting the origin of the median fins, which are founded upon the theory of ontogeny.—*John A. Ryder. Nov. 3d, 1884.*

EXPLANATIONS OF FIGURES.

FIG. 1.—Larval Branchiostoma, (after Kowalevsky); almost perfectly archicercal.

FIG. 2.—*Chimæra monstrosa*, with an archicercal opisthural filament, (after Agassiz).

FIG. 3.—Lophocercal larva of the codfish, with continuous median fin-fold, *f f f f*.

FIG. 4.—Ideal diphycercal tail, nearly as in Ceratodus and Protopterus.

FIG. 5.—Ideal archaic heterocercal tail, somewhat as found in sturgeons and sharks.

FIG. 6.—Heterocercal tail of larval Lepidosteus (after Balfour and Parker), showing epural and hypural pieces undeveloped at the end of the chorda.

FIG. 7.—Tail of a very young Lepidosteus (from the same source), showing the opisthure, *op*, above the secondary or true caúdal, *sc*.

FIG. 8.—Caudal skeleton of a larval Amiurus, fifteen days old. *op*, opisthural, *hy*, hypural, and *cp*, epural cartilages; *u*, urostyle; *m*, medulla spinalis; *ch*, chorda, invested by the skeletal tissue, *sk*, of the caudal vertebræ.

PHYSIOLOGY.[1]

THE THERAPEUTIC EFFECTS OF OXYGEN AND OF OZONE.—It is a popular error that breathing pure oxygen would prove destructive to animal life by greatly accelerating combustion in the body as it does of the fuel of an ordinary fire. Filipow has lately submitted the question of the physiological action of oxygen and ozone to exact experiment on men and dogs; his results may be summed up as follows: 1. Breathing pure oxygen is followed by no effects which distinguish its action from that of pure atmospheric air, at least as regards pulse, respiration and body temperature. 2. In cases of poisoning with chloroform, alcohol, sulphuretted hydrogen or carbonic oxide, respiration of pure oxy-

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[1] This department is edited by Professor HENRY SEWALL, of Ann Arbor, Mich.